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Title: Template size and proper overlap detection in Laser Confocal Microscope (LCM) images

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Template size and proper overlap detection in Laser Confocal Microscope (LCM) images

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CCS-6

5 August 2021

LA-UR-21-

The LCM has been used to interrogate the inside of hazardous material 3013 storage containers resulting in many LCM images

- Joining these images together to create one large image allows one to see features, potential cracking and potential pitting, that extend from one image to another
- The images have been found to cover some (5% – 10% at the edges) of the same sample area
- This overlap appears to change slightly from image to image so that a global overlap value does not solve the stitching problem
- It will be necessary to determine the proper overlap for two adjacent, horizontal or vertical, images
- The methodology presented here shows how to estimate the overlap
- Once estimated the overlap may be account for and a final stitched image created
- The overlap uses a template from the image edge that is overlapped with the adjacent image
- The height of the template will be the entire height of the image (for horizontal overlap)
- The width of the template is what will be studied herein

How does the template size affect the accuracy of the overlap detection?

- Various template widths in pixels:
 - 1
 - 10
 - 50
 - 100
 - 125
 - 250
 - 400
 - 500
 - 1024

Explanation of the following figures

Template matching overlap algorithm. To be integrated into the overall LCM stitching program.

As an example use LCM images 7 and 8. Image 8 is to the right of image 7. We will try various template widths in pixels – “w”.

The top row of the first column is the right w pixels of image 7 and image 7. The bottom row of the first column is the left w pixels of image 8 and image 8. The left w pixels of image 8 will be called the “template”.

The center image is created by finding the correlation of the template for all pixels and for every location in image 7.

The template is “moved around” to each location and the correlation between the pixels is computed.

By brute force this would take a while to compute but there are update formulas that make it very fast.

When the template lands on the best (or correct) spot then the correlation is nearest the value 1.

This location/point is indicated by a red dot in the middle column/center image.

The location of the template in the image is known so we can locate the entire image 8 correctly with overlap onto image 7.

There are multiple ways to do this. One could average the overlapping pixel values or just choose the ones from one or the other image. What is best for this overlap area? The answer may be related to the different intensity ranges for the different figures. This would lead one to believe that averaging may be best – but not simplest.

Right Side of: 'LCMIntensity_Y10_X7'
Right Side Width in Pixels = 1

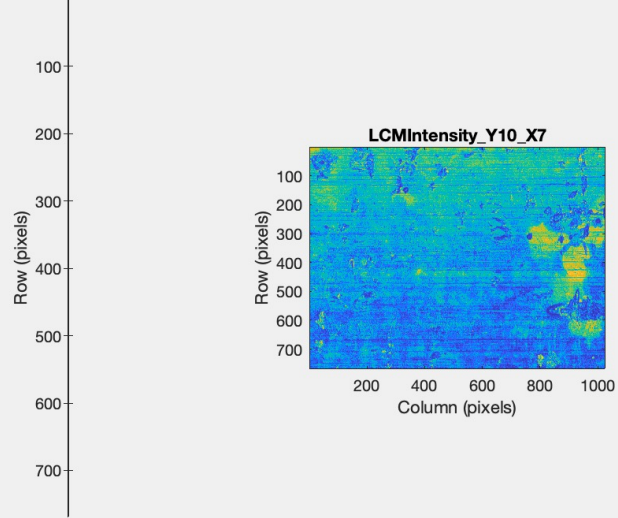
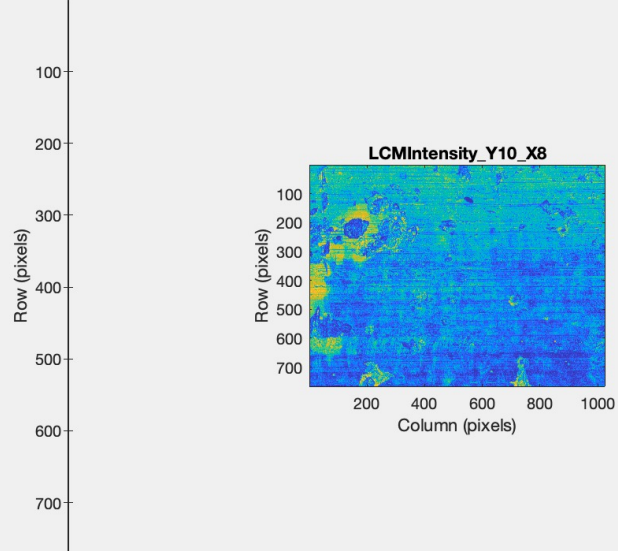


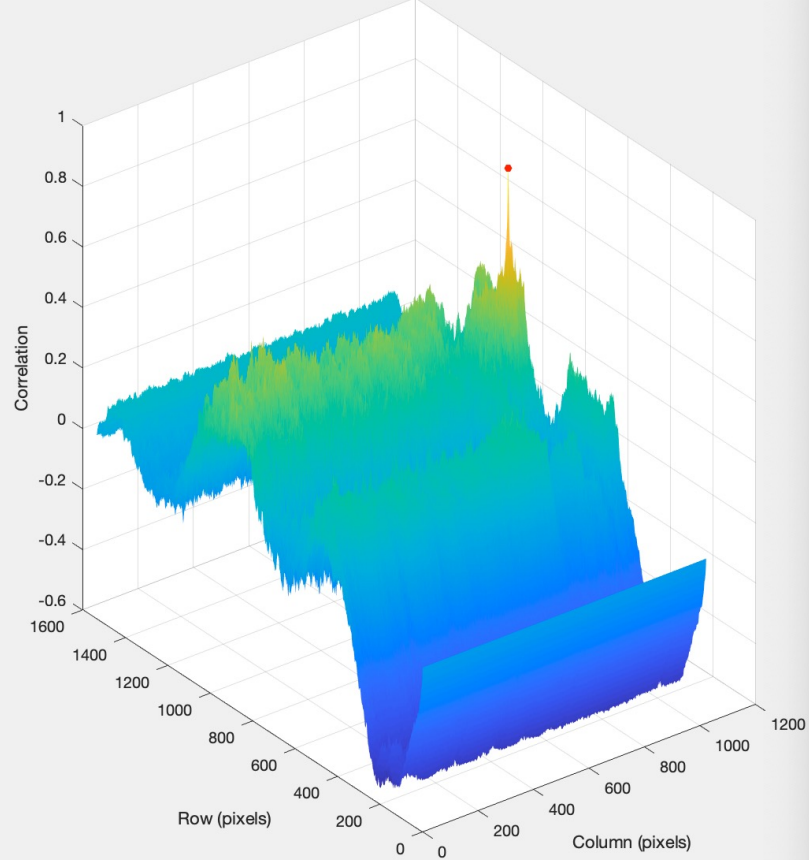
Figure 5000

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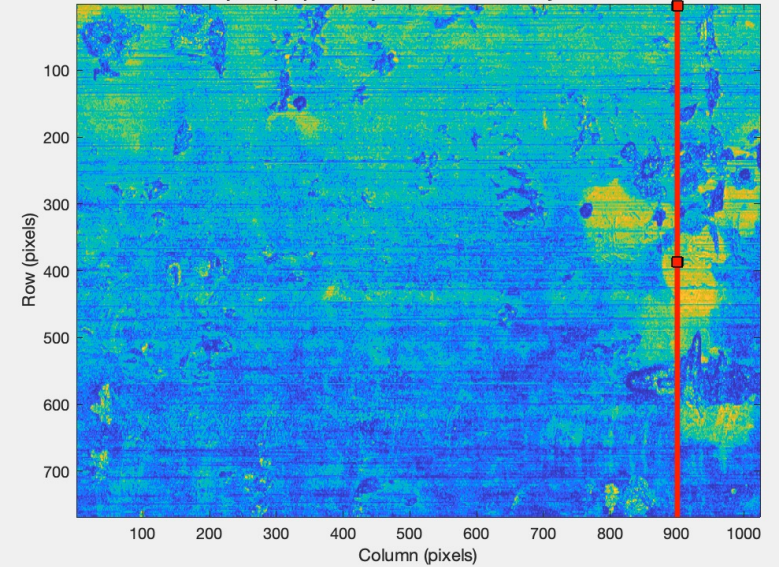
Left Side of: LCMIntensity_Y10_X8
Left Side Template Width in Pixels = 1



Optimization to Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Red dot is located at the maximum correlation match



Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Translation of the template (red) in the Vertical Direction: 2 pixels
Translation of the template (red) in the Horizontal Direction: 125 pixels
Template (red) size in pixels is: 1024 rows by 1 columns



Right Side of: 'LCMIntensity_Y10_X7'
Right Side Width in Pixels = 10

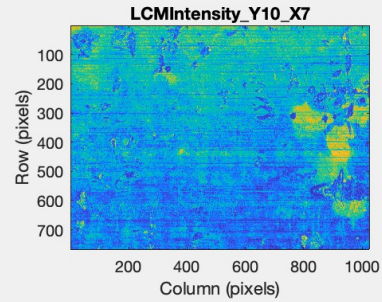
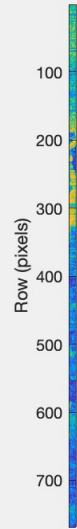
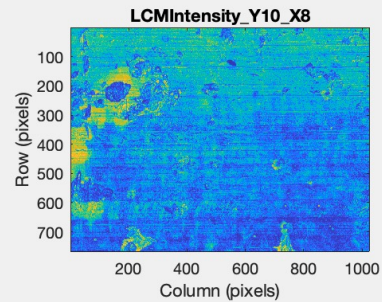
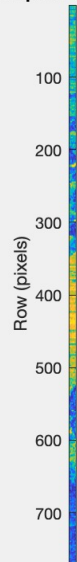


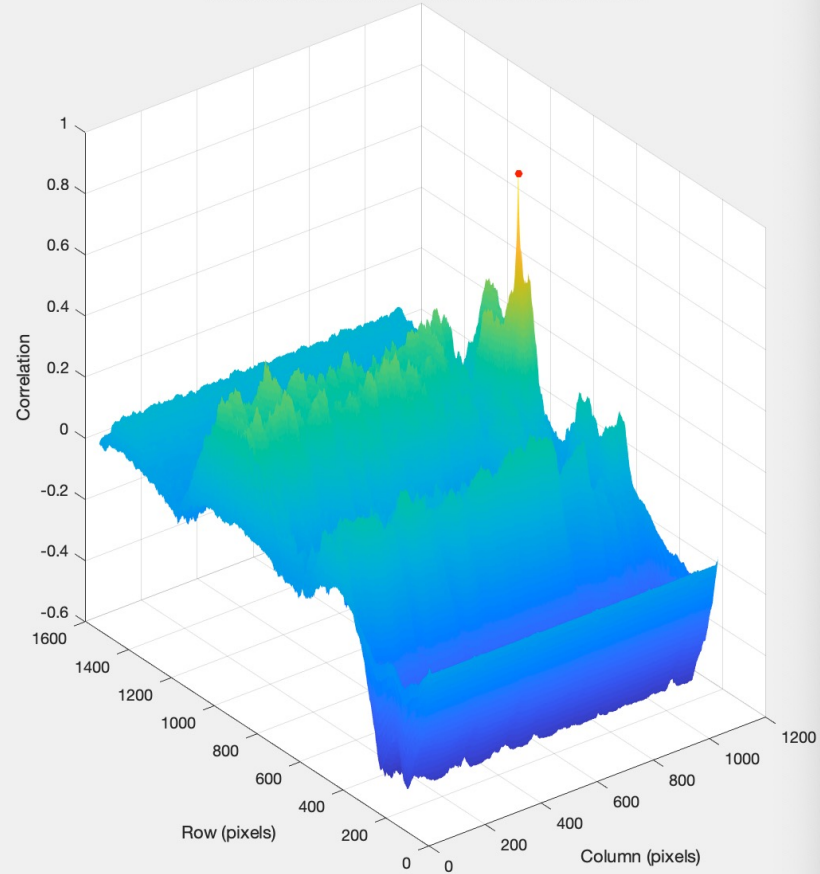
Figure 5000

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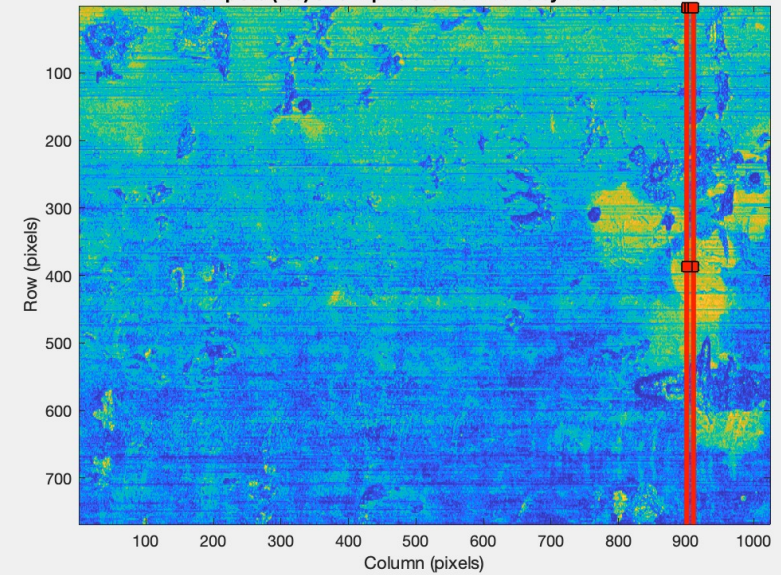
Left Side of: LCMIntensity_Y10_X8
Left Side Template Width in Pixels = 10



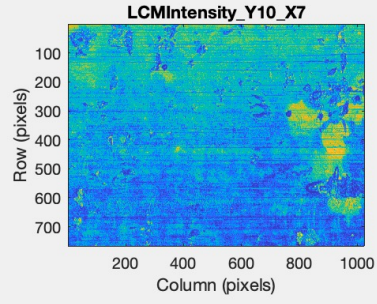
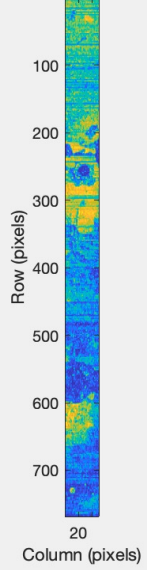
Optimization to Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Red dot is located at the maximum correlation match



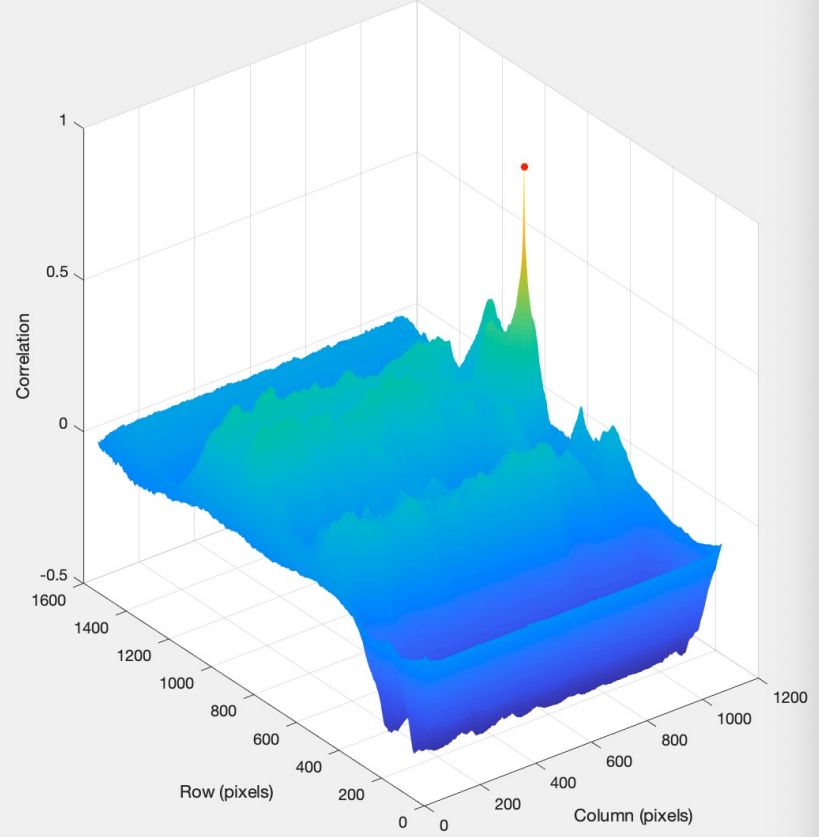
Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Translation of the template (red) in the Vertical Direction: 2 pixels
Translation of the template (red) in the Horizontal Direction: 124 pixels
Template (red) size in pixels is: 1024 rows by 10 columns



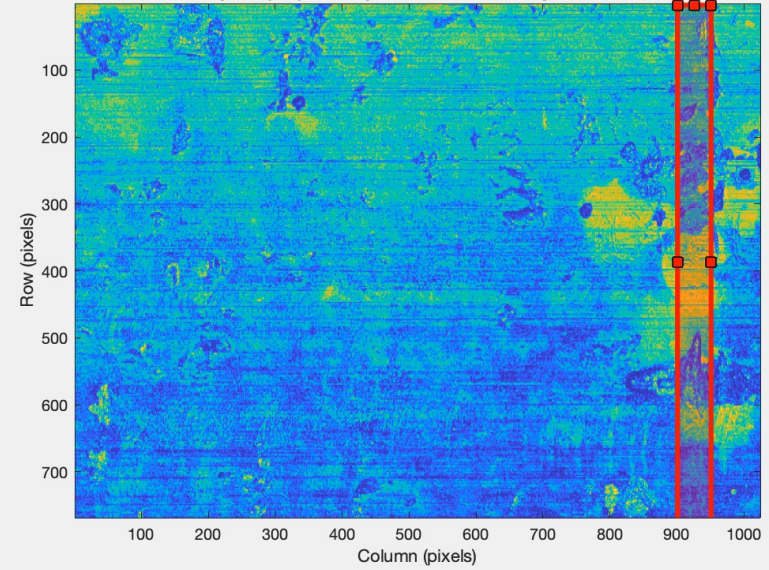
Right Side of: 'LCMIntensity_Y10_X7'
Right Side Width in Pixels = 50



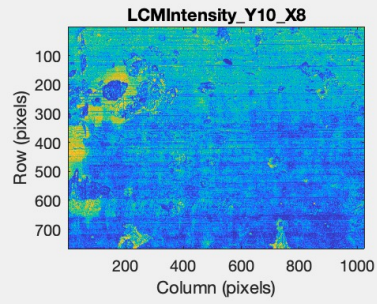
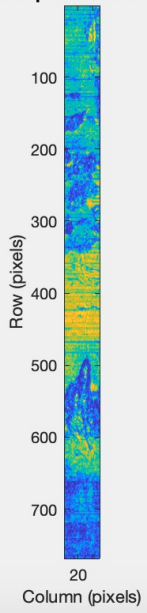
Optimization to Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Red dot is located at the maximum correlation match



Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Translation of the template (red) in the Vertical Direction: 2 pixels
Translation of the template (red) in the Horizontal Direction: 124 pixels
Template (red) size in pixels is: 1024 rows by 50 columns



Left Side of: LCMIntensity_Y10_X8
Left Side Template Width in Pixels = 50



Right Side of: 'LCMIntensity_Y10_X7'
Right Side Width in Pixels = 100

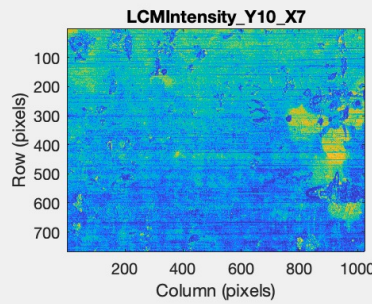
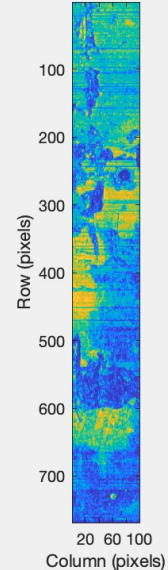
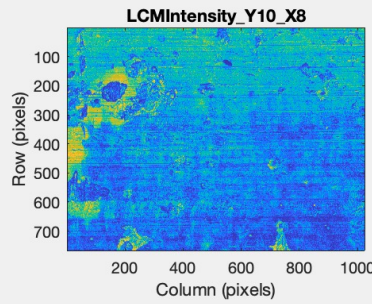
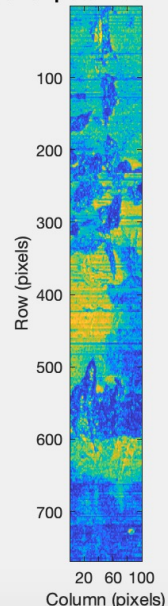


Figure 5000

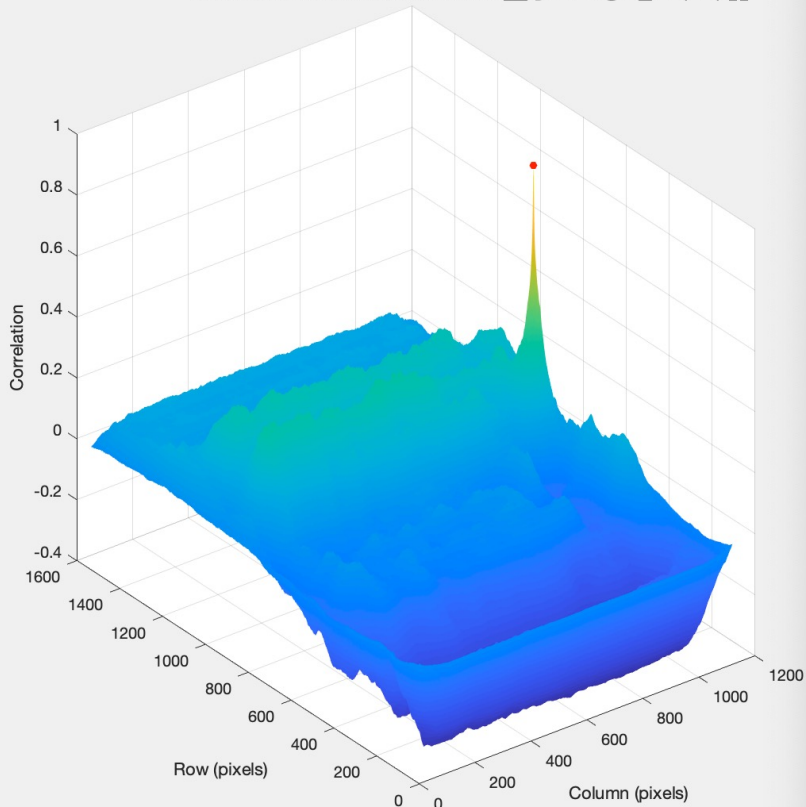
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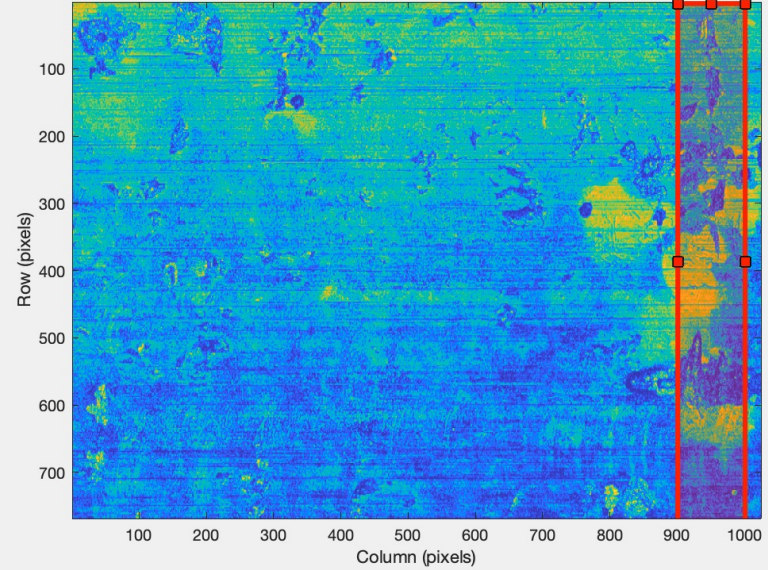
Left Side of: LCMIntensity_Y10_X8
Left Side Template Width in Pixels = 100



Optimization to Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Red dot is located at the maximum correlation



Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Translation of the template (red) in the Vertical Direction: 2 pixels
Translation of the template (red) in the Horizontal Direction: 124 pixels
Template (red) size in pixels is: 1024 rows by 100 columns



Right Side of: 'LCMIntensity_Y10_X7'
Right Side Width in Pixels = 125

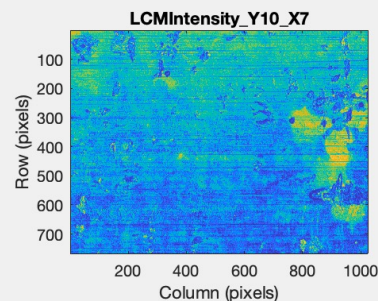
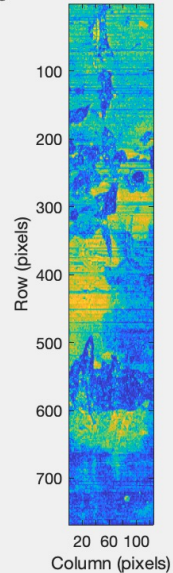
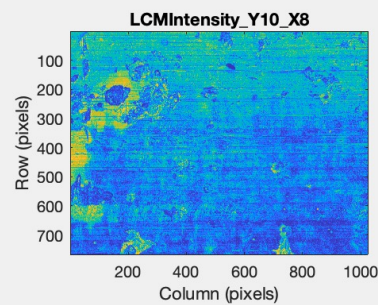
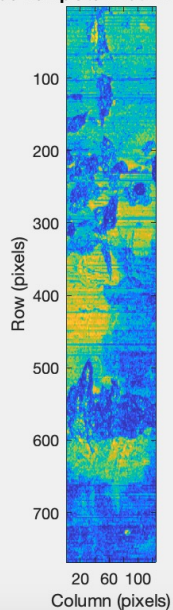


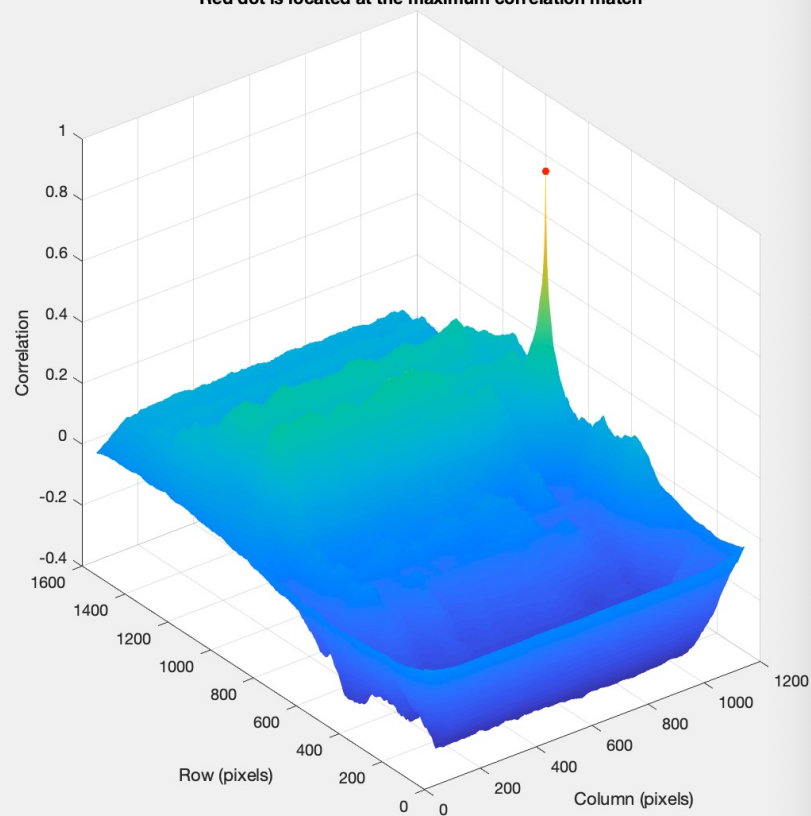
Figure 5000

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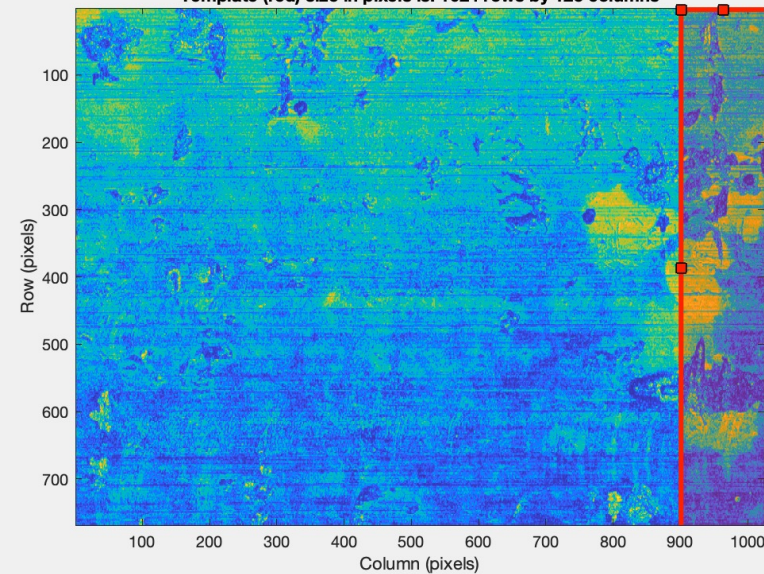
Left Side of: LCMIntensity_Y10_X8
Left Side Template Width in Pixels = 125



Optimization to Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Red dot is located at the maximum correlation match



Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Translation of the template (red) in the Vertical Direction: 2 pixels
Translation of the template (red) in the Horizontal Direction: 124 pixels
Template (red) size in pixels is: 1024 rows by 125 columns



Right Side of: 'LCMIntensity_Y10_X7'
Right Side Width in Pixels = 250

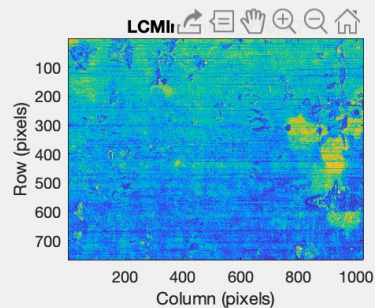
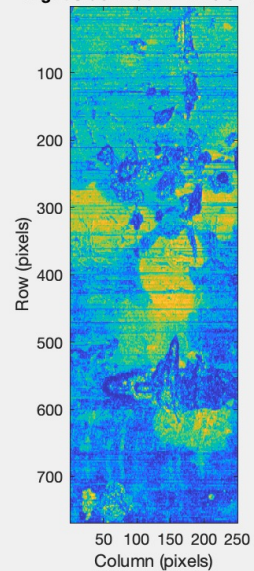
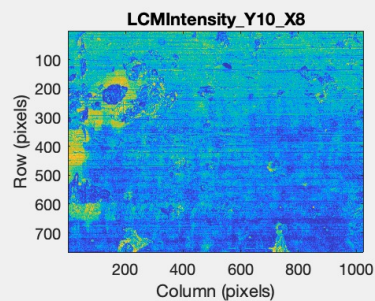
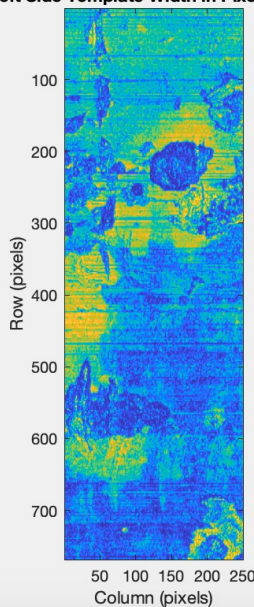


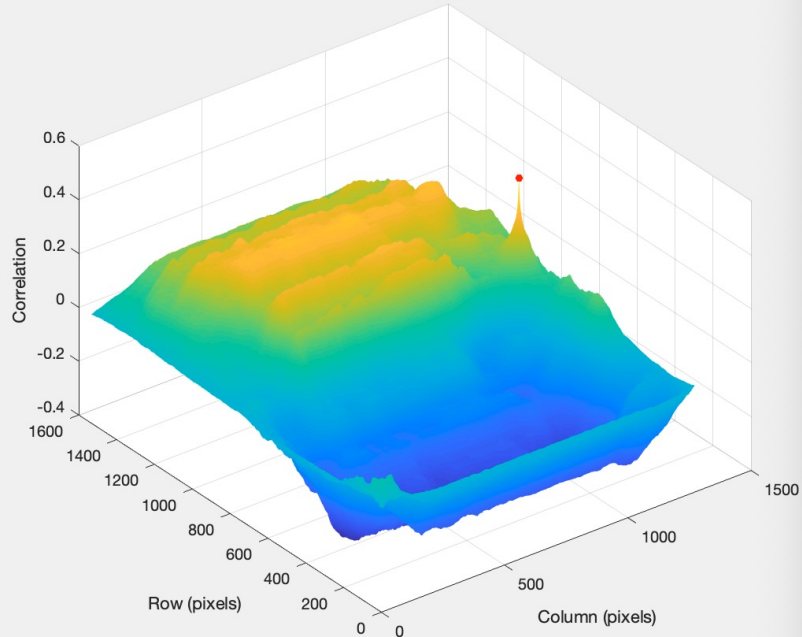
Figure 5000

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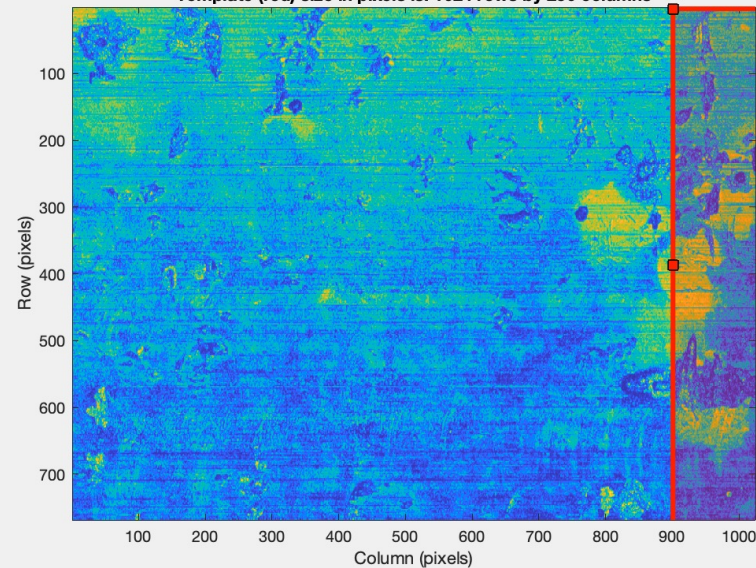
Left Side of: LCMIntensity_Y10_X8
Left Side Template Width in Pixels = 250

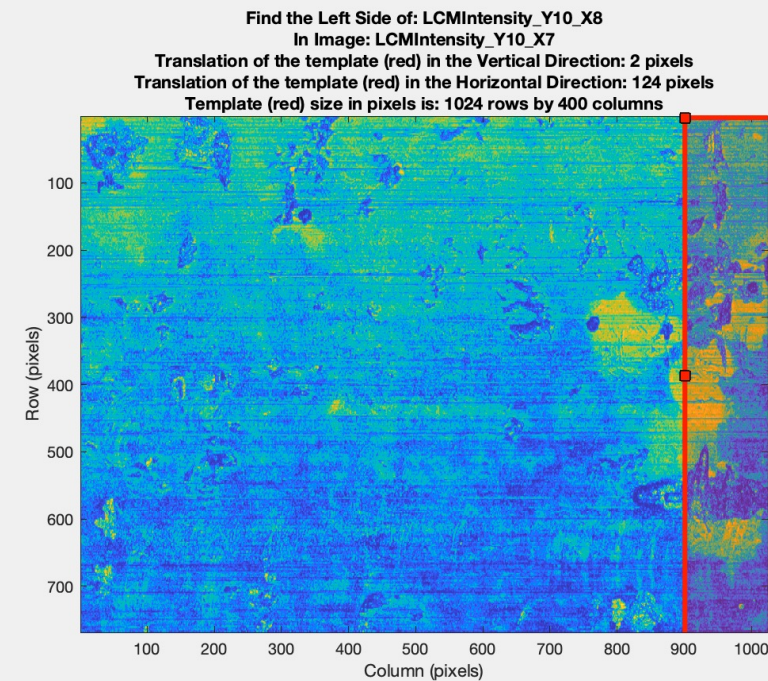
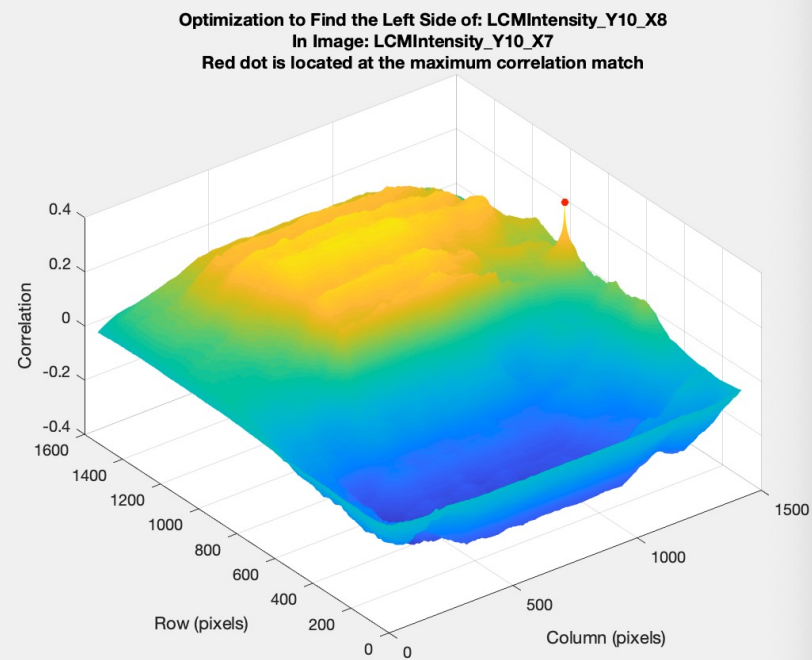
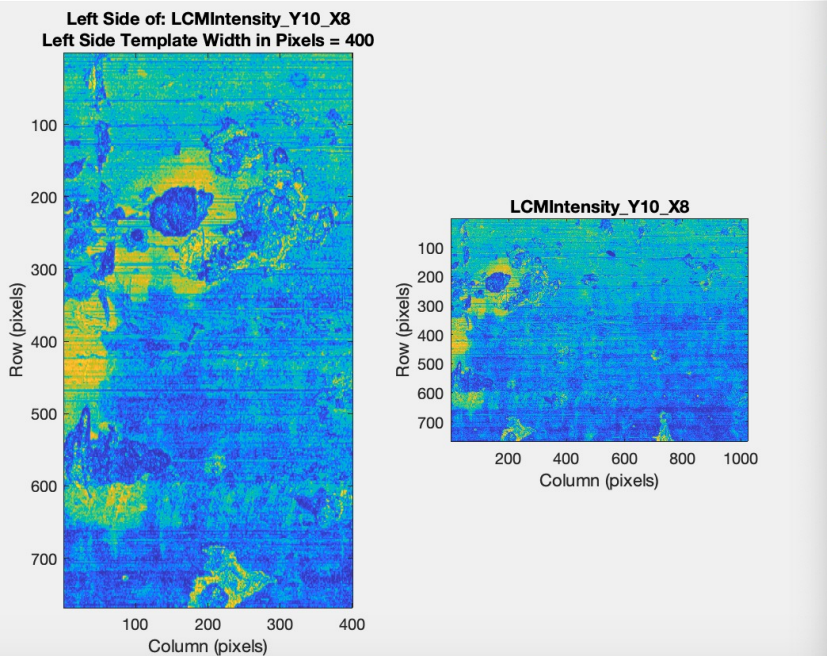
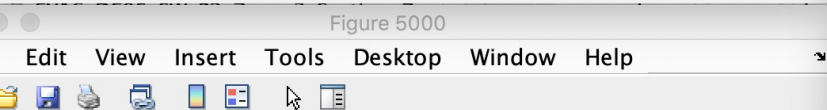
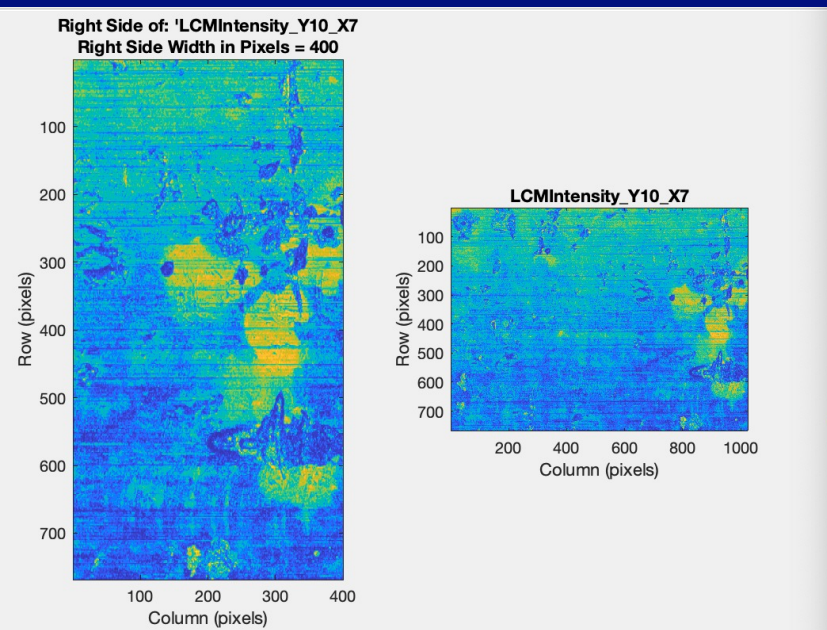


Optimization to Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Red dot is located at the maximum correlation match

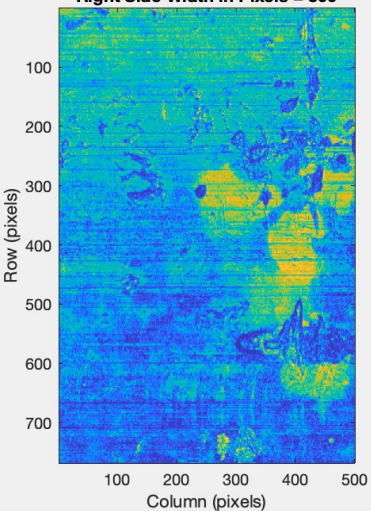


Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Translation of the template (red) in the Vertical Direction: 2 pixels
Translation of the template (red) in the Horizontal Direction: 124 pixels
Template (red) size in pixels is: 1024 rows by 250 columns





Right Side of: 'LCMIntensity_Y10_X7'
Right Side Width in Pixels = 500



LCMIntensity_Y10_X7

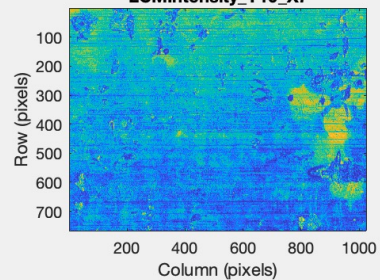
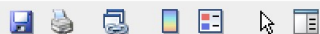
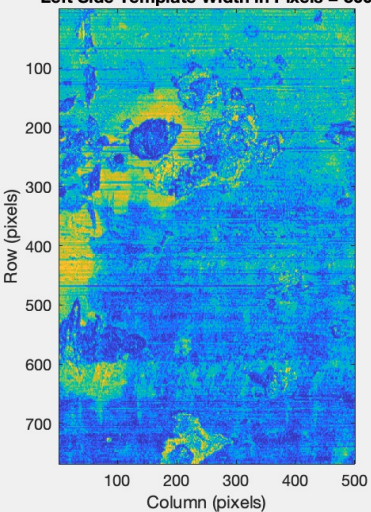


Figure 5000

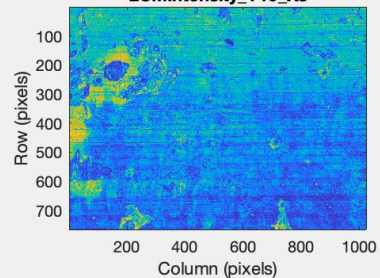
Edit View Insert Tools Desktop Window Help



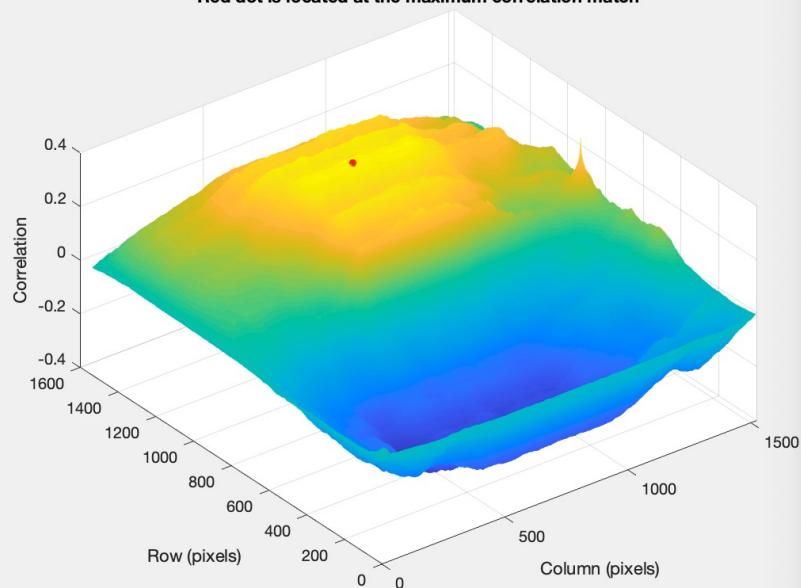
Left Side of: LCMIntensity_Y10_X8
Left Side Template Width in Pixels = 500



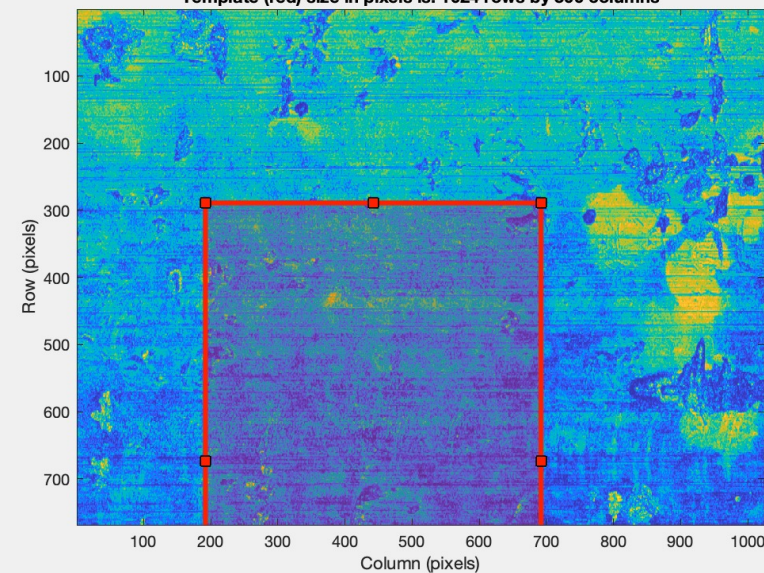
LCMIntensity_Y10_X8

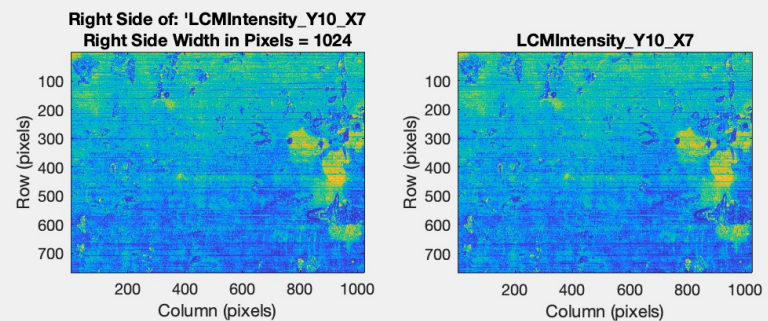


Optimization to Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Red dot is located at the maximum correlation match



Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Translation of the template (red) in the Vertical Direction: 288 pixels
Translation of the template (red) in the Horizontal Direction: 833 pixels
Template (red) size in pixels is: 1024 rows by 500 columns

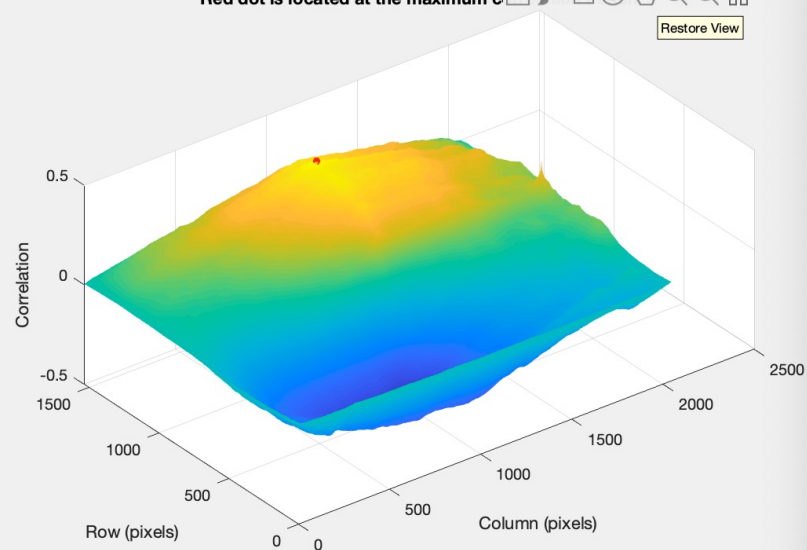




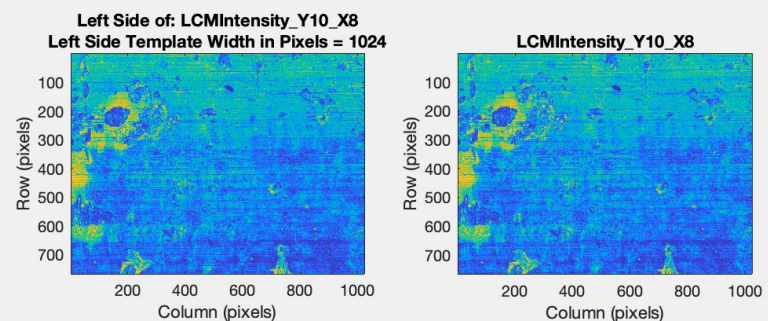
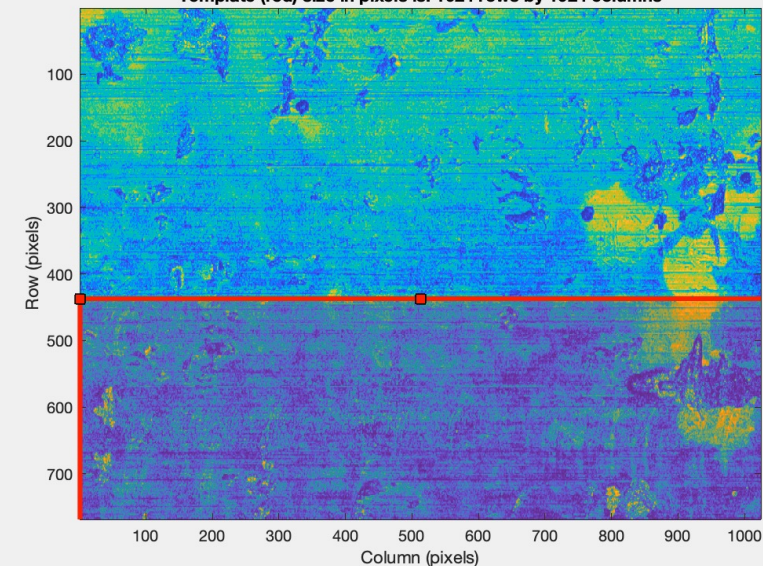
Optimization to Find the Left Side of: LCMIntensity_Y10_X8

In Image: LCMIntensity_Y10_X7

Red dot is located at the maximum correlation



Find the Left Side of: LCMIntensity_Y10_X8
In Image: LCMIntensity_Y10_X7
Translation of the template (red) in the Vertical Direction: 436 pixels
Translation of the template (red) in the Horizontal Direction: 1024 pixels
Template (red) size in pixels is: 1024 rows by 1024 columns



How does the template size affect the accuracy of the overlap detection?

Various template widths in pixels:

- 1
- 10
- 50
- 100
- 125
- 250
- 400
- 500
- 1024

Various template widths in pixels:

- Adequate with other peaks
- Adequate with other peaks
- Fairly well defined peak
- Well defined peak
- Well defined peak
- Other areas are near the peak value
- Other areas are near the peak value
- Wrong place identified
- Wrong place identified

Conclusion

- The overlap area has been seen in LCM images to be between 5% and 10% of the 1024 pixels
- This is around between 50 to 100 pixels in width
- A value of 100 pixels for the template width works in this example and is buffered by working values both above and below 100 pixels
- 100 pixels will be used for the template width in the future LCM overlap algorithm